REMARKS

Applicant hereby replies to the Final Office Action dated February 4, 2010. Applicant thanks the Examiner for carefully considering the application. Applicant notes that the amendments to the specification are fully supported by the original specification.

Status of Claims

Claims 1, 3-27 and 29-33 are pending in the above-referenced patent application. Claims 1, 31, and 32 are independent.

Claims 8-18 are objected to for informalities. Claims 1, 3, 8, 11-24 and 31-33 were rejected under 35 U.S.C. §102(b) as being anticipated by prior art. Claims 1, 3, 6-8, 11-24 and 31-33 were rejected under 35 U.S.C. §103(a) as being unpatentable over prior art in view of Applicant's specification. Claims 4-5, 25-27 and 29-30 were rejected under 35 U.S.C. §103(a) as being unpatentable over prior art.

Claim Amendments

Claims 1, 8, 14-17, 31 and 32 are amended for clarification. No new matter is added.

Claim Objections - *Claims 8-18*

Claims 8-18 were rejected for informalities. Applicant has amended claims 8, 14-17 as suggested in the Office Action to overcome the informal objections. Accordingly, withdrawal of the informal objections are respectfully requested.

Rejection under 35 U.S.C. 102(b) – Claims 1, 3, 8, 11-24 & 31-33

Claims 1, 3, 8, 11-24 and 31-33 were rejected under 35 U.S.C. §102(b) as being anticipated by EP 0680810 A1 ("EP 810"). Applicant respectfully traverses these rejections because, for at least the following reasons, EP 810 does not disclose all of the claimed limitations described in the current application.

One of the basic goals in modern organic chemistry is not only to create new synthetic processes to develop novel chemical compounds, but also to discover new synthetic strategies to improve current chemical processes in producing known chemical compounds or compositions. Some of the improvements that are frequently made in known chemical processes are, among many others, producing better yields of the final product, developing alternative synthetic processes, or creating more efficient processes of producing the final product, such as by reducing the number of steps required to obtain the final product, reducing the reaction time, or using less hazardous materials. Here, the current application claims a novel and more efficient process of impregnating and acetylating wood and wood products (herein collectively, the "wood") that was not previously disclosed in EP 810, by improving the yield in the acetylated product, and significantly reducing the number of steps in the chemical process and the duration of the chemical reaction.

EP 810 discloses the conventional method of treating wood in a multiple-steps chemical process, which is basically divided into two major steps of: (1) first, impregnating (injecting) the wood with the desired acetylating agent, and (2) subsequently, following the initial impregnation process, heating the wood impregnated with said acetylating agent to allow acetylation chemical reaction to take place within the wood. In sharp departure from this conventional method, the

current application introduces a novel method of impregnating and acetylating the wood in an efficient and aggressive simultaneous impregnation-acetylation process in liquid phase using high temperature and gaseous pressure.

EP 810, in its detailed specification, describes its multiple-steps process essentially as follows:

1. A piece of solid wood to be treated is placed in a vessel. The wood can optionally be treated cold or warm. If warm wood is desired, then the vessel is preheated to a temperature in the range of 30-50°C.
2. The subsequent step can be carried out in three (3) alternative options:
    a. vacuum or preliminary pressure is first applied to the vessel containing the wood (the "treatment vessel") for a period of time (e.g. 1 hour), and then liquid acetic anhydride (the "acetylating agent") from a separate vessel (the "acetylating agent vessel") is added to the treatment vessel; or
    b. the treatment vessel is first filled with liquid acetic anhydride from the acetylating agent vessel, and then vacuum is applied to the treatment vessel for a period of time; or
    c. the liquid acetic anhydride from the acetylating agent vessel is added directly to the treatment vessel, without any preliminary pressure, preliminary vacuum, or further vacuum.

    In this step 2, the liquid acetic anhydride can be added to the treatment vessel either warm (in the range of 30-150°C), or cold (less than 70°C). If the liquid acetic anhydride is added cold, then the solution is heated during the

impregnation process. If the liquid acetic anhydride is added warm, then a heating device is provided to the acetylating agent vessel to keep the liquid acetic anhydride warmer than room temperature (30-150°C) prior to adding to the treatment vessel.

3. After the addition of the liquid acetic anhydride to the treatment vessel, the wood is then impregnated with said liquid acetic anhydride for a period of time, ranging from a few minutes to several hours, depending on the dimensions and species of wood used. The impregnation process can be performed in several possible combinations of alternative options:
   a. Without pressure or a vacuum;
   b. With pressure in the range of 2-15 bar; or
   c. With a vacuum; and
   d. In cold temperature; or
   e. In heated temperature.
4. Subsequent to the impregnation process, the acetylation reaction in the wood can be carried out in two alternative options:
   a. the wood is first heated by applying heat to the treatment vessel, i.e. surrounding the wood with hot liquid acetic anhydride, followed by draining the wood of excessive acetic anhydride; or
   b. the wood is first drained of excessive acetic anhydride, and then heated.

In this step 4, the acetylation reaction can generally take up to 24 hours, and the temperature of the treatment vessel is set at a range of 70-150°C.

5. After the acetylation reaction is complete, a final vacuum is applied to the treatment vessel to extract as much non-reacted acetic anhydride and by product acetic acid from the wood. In this step, optional further heating at the temperature used for the acetylation reaction may be applied to the treatment vessel. This final vacuum step should take between 0.2 to 5 hours.
6. Finally, after the final vacuum is complete, a steam or water treatment under atmospheric pressure, vacuum or pressure is applied to the treatment vessel for a period of time to further remove the remaining non-reacted acetic anhydride and by product acetic acid in the wood.

On the other hand, the current application claims a more efficient process of impregnating and acetylating wood by reducing the number of steps and reaction time to obtain the acetylated final product, essentially as follows:

1. The acetylating agent in the acetylating agent vessel is pre-heated to a temperature above the atmospheric boiling point of the acetylating agent, which is in the range of 150-250°C, to form a working solution (the "working solution") at a super hot temperature, wherein sufficient pressure is applied throughout the preheating step to ensure that the entire working solution is maintained in a liquid phase and not boil off.
2. Subsequent to the pre-heating step of the working solution, the wood in the treatment vessel is then contacted with the working solution at said super hot temperature and at an elevated pressure, such that the entire working solution remains in the liquid phase, to cause impregnation of the working solution into the

wood and acetylation reaction to take place aggressively and simultaneously. Optionally, but preferably, prior to contacting the wood with the working solution, the wood in the treatment vessel is also subjected to pre-pressure by a gas selected from nitrogen, air, carbon dioxide, argon, acetic acid vapor or acetic anhydride vapor, sufficient to maintain the entire super hot working solution in the liquid phase upon its introduction into the treatment vessel. The simultaneous impregnation-acetylation reaction time takes <u>up to 4 hours</u>.

3. After the impregnation and acetylation reaction is complete, the remaining non-reacted acetylating agent, by products, and any waste materials in the wood are then separated from the treatment vessel. Optionally, said remaining non-reacted acetylating agent, by products, and any waste materials can be further removed by either releasing the pressure in the treatment vessel to cause said non-reacted acetylating agent, by products, and waste material to boil off, or, alternatively, by applying a vacuum to the treatment vessel.

As demonstrated above, the method claimed in the current application is a remarkable improvement in the method of wood treatment/acetylation process that is very distinctive from the traditional method disclosed in EP 810, in that the current application claims a novel method that requires significantly less steps and less acetylation reaction time. Further, as the results of the experiments of both EP 810 and the current application reported, acetylation process performed by the method claimed in the current application generally yields up to 28% weight gain in the wood (which is one way of measuring the extent of acetylation in the wood), whereas the acetylation process performed by the method disclosed in EP 810 yields only up to 24%

weight gain in the wood.

Contrary to the position stated in the Office Action, the method disclosed in EP 810 does not directly or inherently teach or suggest that prior to impregnating the wood, the entire working solution containing the acetylating agent is required to be specifically pre-heated to a super hot temperature of 150-250°C and subjected to an elevated pressure in the acetylating agent vessel to ensure that it remains in the liquid phase. This is confirmed by the flow chart of the process illustrated in the drawing marked as "Fig." on page 7 of EP 810. Instead, as seen in Step 2 of EP 810 above, prior to impregnating the wood, the method described in EP 810 offers three alternative options of either (1) first, applying vacuum or preliminary pressure to the treatment vessel containing the wood for a period of time (e.g. 1 hour), and then adding the liquid acetic anhydride from the acetylating agent vessel to the treatment vessel; (2) first, filling the treatment vessel with the liquid acetic anhydride from the acetylating agent vessel, and then applying vacuum to the treatment vessel for a period of time; or (3) adding the liquid acetic anhydride from the acetylating agent vessel directly to the treatment vessel, without any preliminary pressure, preliminary vacuum, or further vacuum.

Step 2 of EP 810 also provides, that as an option, the liquid acetic anhydride can be added to the wood either cold or warmer than room temperature. Step 2 of EP 810 defines "warmer than room temperature" as a temperature between 30-150°C, which can be achieved by providing a heating device to the acetylating agent vessel. This range of temperature is significantly outside of the range of the super hot temperature of the preheated working solution prescribed by the current application, which sets forth a temperature in the range of 150-250°C, and most preferably, as described in the current application's specification, a temperature in the range of

170-200°C. Further, there is no teaching or suggestion in Step 2 of EP 810, that if "warmer than room temperature" acetic anhydride is desired, then in addition to pre-heating it to a temperature in the range of 30-150°C, the liquid acetic anhydride in the acetylating agent vessel must be subjected to an elevated pressure to ensure that it stays in the liquid phase.

EP 810 discloses no such teaching, suggestion, or requirement to preheat the liquid acetic anhydride to a super hot temperature while applying sufficient pressure throughout the preheating step to ensure the entire working solution is maintained in the liquid phase, as claimed by Applicant. As the temperature of the working solution is increased to such a high degree, the working solution begins to boil off and becomes gaseous. The application of sufficient pressure in the preheating step ensures that the gaseous working solution is subsequently condensed back into its liquid form, and the working solution remains in its liquid phase upon contact with the wood. Maintaining the entire working solution in liquid phase at a super hot temperature maximizes the loading of the acetic anhydride into the wood, and simultaneously, causes extremely rapid acetylation reaction in the wood. As the results have shown, this novel method results in less steps in the process, significantly faster acetylation reaction time than the method prescribed by EP 810, and produces a better yield in acetylated final product.

Based on the aforementioned, Applicant respectfully submits there is no teaching that is explicitly inherent in EP 810 suggesting that the working solution should be preheated to a super hot temperature, wherein sufficient elevated pressure is applied throughout the preheating step to ensure that the entire working solution is maintained in liquid phase.

As to claim 8, in addition to the reasons presented above, Applicant further argues that while EP 810 discloses an optional step of applying pressure to the treatment vessel during

impregnation, EP 810 does not teach or suggest the requirement of maintaining the entire working solution in liquid phase at a super hot temperature, in addition to applying the working pressure, to simultaneously maximize the loading of the acetic anhydride into the wood and cause extremely rapid acetylation reaction in the wood. In sharp departure from the method described in EP 810, claim 8 requires all the elements of applying elevated pressure, bringing the entire working solution to a super hot temperature, and maintaining the entire working solution in liquid phase to take place during the entire impregnation-acetylation process. Therefore, EP 810 fails to disclose the limitations claimed in claim 8 of the current application.

As to claims 11-13, as discussed above, the method of wood treatment disclosed by EP 810 is consisted of first the impregnation step, subsequently followed by the acetylation reaction. The duration in EP 810 cited in the Office Action regarding claims 11-13 includes only the impregnation step, and not the acetylation reaction step. On the contrary, the novel claimed method of the current application includes a simultaneous process of aggressive impregnation and rapid acetylation reaction, and the duration specified in claims 11-13 pertain to the entire simultaneous process of impregnation step and acetylation reaction step. Therefore, EP 810 fails to disclose the teachings of claims 11-13 of the current application.

As to claims 21-22, EP 810 does not disclose the claimed process. To help illustrate, Applicant's Figure 1 illustrates a preferred mechanical diagram of the actual device/system used in performing the method, in which a vessel containing the working solution ("Vessel 101") is directly connected to a pressure source controlled by valve 109. On the other hand, the drawing labeled "Fig." attached to EP 810 merely describes the diagram of each procedural step, and not the actual mechanical device/system. There is no description of whether there is such an

apparatus called a "warming vessel" used in the device/system as cited in the Office Action, and whether the "Acetic Anhydride Storage" depicted in Fig., or a "warming vessel," if it existed, is connected to a pressure source. The specification in EP 810 only briefly describes that "In the case of the addition of an acetic anhydride solution being warmer than the room temperature, a heating device is provided, from which the heated acetic anhydride solution is supplied to the treatment container." (See page 3 of EP 810, lines 16-18). Again, there is no mention that a separate "warming vessel" for the working solution is used in the system, and there is no mention in the specification, claims, or drawing of EP 810 that a pressure source is connected to the "Acetic Anhydride Storage", or to a "warming vessel," if such an apparatus existed. Therefore, EP 810 does not disclose a storage vessel for the working solution and a warming vessel which can be considered a pressure vessel.

In view of the reasons proffered above, Applicant submits that EP 810 fails to disclose all of the claimed limitations of independent claims 1, 31, and 32 of the current application, and independent claims 1, 31, and 32 are patentable over EP 810 for at least the reasons set forth above. Additionally, the claims that directly or indirectly depend on claims 1, 31, and 32, namely claims 3, 8, 11-24, and 33, are also patentable over EP 810 for at least the same reasons.

Rejections under 35 U.S.C. §103(a) – Claims 1, 3, 6-8, 11-24 & 31-33

Claims 1, 3, 6-8, 11-24 and 31-33 were rejected under 35 U.S.C. §103(a) as being unpatentable over EP 810 in view of Applicant's specification. Claims 4-5 were rejected under 35 U.S.C. §103(a) as being unpatentable over EP 810 in view of U.S. Patent No. 5,679,407 issued to Mansikkamaki et al. ("US 407") or U.S. Patent No. 4,466,998 issued to McIntyre et al.

("US 998"). Claims 25-27 and 29-30 are rejected under 35 U.S.C. §103(a) as being unpatentable over EP 810 in view of U.S. Patent No. 6,376,582 issued to Iwata et al. ("US 582"). Applicant respectfully traverses these rejections for at least the following reasons: EP 810, US 407, US 998, and US 582, either separately or combined, do not disclose all of the claimed limitations.

In addition to the arguments set forth in the previous section, which also address the Office Action's rejections of Applicant's claims under § 103(a) in this section, it is worth emphasizing that the traditional acetylation process taught by EP 810 of subsequently heating pre-impregnated, saturated wood to react the acetic anhydride within the wood, does not solve the poor efficiency of the process due to the mass of acetic anhydride in the wood, the poor heat conductivity of the wood, the fact that wood heating is by conduction rather than convection, the problem with uneven heat distribution throughout the solid wood, which in turn causes uneven acetylation, and the extremely long period of total treatment, reaction, and recovery period. On the contrary, the current application's novel claimed method of preheating the working solution at a super hot temperature under elevated pressure and maintaining the entire working solution in liquid phase throughout the process, solves at least some of these problems. Therefore, the Applicant's novel claimed method would not have been obvious to one of ordinary skill in the art.

As to claims 6-7, EP 810 does not even disclose the step of preheating the working solution to a super hot temperature under elevated pressure to maintain the entire working solution in liquid phase. Therefore, such preheating step, which includes applying pressure to the working solution, would not have been obvious to one of ordinary skill in the art.

As to claims 9-10, the pre-pressure process using a pressure of 2-15 bar in EP 810 was

cited. However, claims 9-10 pertain to the "working pressure" applied during the impregnation-acetylation process, and not during the initial pre-pressure prior to the impregnation-acetylation process, at a pressure of 20 to 4000 kPa above the initial pre-pressure. Therefore, claims 9-10 are not obvious over EP 810.

As to claims 21-22, all of Applicant's response above, particularly Applicant's response to the rejection of claims 21-22 under § 102(b), also applies here.

As to claims 4-5 under § 103(a) as being unpatentable over EP 810 in view of US 407 or US 998, Applicant respectfully submits that US 407 discloses a method for hardening wood material by (1) impregnating it with a polymerizable substance and (2) polymerizing the polymerizable substance inside the wood material by means of immersing the wood material in hot water (at a temperature of 40-200°C), while maintaining the water at a pressure above the atmospheric pressure. US 407 does <u>not</u> disclose applying a pre-pressure to a wood <u>prior to impregnation</u> using N_2 gas. Instead, US 407 merely provides a brief description that "It is advisable to use nitrogen gas already <u>at the impregnation</u> stage" (see column 3, lines 17-18) and "The impregnation is by any known impregnation method, for example, by forcing a liquid polymerizable substance into the wood cell tissue by elevated pressure or by impregnating the cell tissue with it by means of vacuum. Overpressure and vacuum can also be combined in a suitable manner to achieve impregnation." (See column 2, lines 56-61 of US 407). There is no mention of applying a pre-pressure to a wood <u>prior to impregnation</u> using N_2 gas in the specification or the claims. The only other use of N_2 gas in the method taught by US 407, aside from its advisable use at the impregnation step, is during the polymerization reaction step of the impregnated wood while the wood is immersed in hot water, to maintain the reaction

environment in a closed system of inert gas and prevent the oxygen of air from interfering with the polymerization reaction. Therefore, since there is no mention of applying a pre-pressure to a wood prior to impregnation using N_2 gas in the specification or the claims of US 407, and the polymerization reaction involved in US 407 is sharply distinct from the acetylation reaction in the current application, it clearly would not have been obvious to one of ordinary skill in the art to apply N_2 gas in an initial pre-pressure step to the wood prior to the impregnation step as prescribed in claims 4-5 in the current application.

US 998 discloses a method of treating wood with water-borne preservative salts, such as chromate copper arsenate salts ("CCA salts"), by using a process called "empty-cell process" at a temperature between 40-70°C. As background, US 998 describes two types of pressure methods of injecting preservatives into wood in closed cylinders, designated as full-cell and empty-cell processes. In the full-cell process, the aim is to retain as much of the liquid forced into the wood during the pressure period as possible, thus leaving the maximum concentration of preservative in the treated zone. In the empty-cell process, on the other hand, part of the preservative forced into the wood under pressure is subsequently recovered, so that the wood is coated with preservative rather than filled with it. (See col 2:34-44 of US 998).

The chief characteristic of the empty-cell process is the application of the preliminary air pressure to the wood, prior to the injection of the preservative oil. Air is injected into the treatment cylinder containing the wood until the desired pressure is obtained, with the result that a certain amount is forced into the wood. The cylinder is then filled with preservative in such a way that the injected air is trapped in the wood. After the filling is completed, the preservative is forced into the wood by the application of higher pressure until the desired absorption is

obtained, thus further compressing the air imprisoned in the wood. The pressure is then released, the preservative drained from the cylinder, and further vacuum is applied. The purpose of releasing the pressure is to expand the compressed air trapped inside the wood and force out a considerable amount of the preservative that was injected. The purpose of the vacuum is to hasten the recovery of oil and shorten the period during which the preservative will continue to drip from the wood. (See col 2:9-42 of US 998).

In contrast, in the current application, applying pre-pressure to the wood using air prior to contacting the wood with the super hot working solution eliminates boiling off of the super hot working solution as it is introduced into the treatment vessel and consequently stop the working solution from cooling. Applicant is also of the position that the high temperature and oxidation free environment ensured by applying pre-pressure to the wood prior to contacting it with the super hot working solution may induce some additional benefits on both stability and biodeterioration resistance of the wood due to thermal treatment.

Therefore, because the application of pre-pressure to the wood using air serves completely distinct purposes and functionality in each of US 998 and the current application, it would not have been obvious to one of ordinary skill in the art to employ the application of pre-pressure to the wood using air in the manner and for the purpose claimed in the current application.

As to the Office Action's rejection of claims 25-27, 29-30 under § 103(a) as being unpatentable over EP 810 in view of US 582, Applicant respectfully submits that US 582 relates to the manufacture of wood fiberboard in which wood fibers which have been subjected to an acetylation treatment and wood fibers which not been subjected to an acetylation treatment are

bonded together using binder resin, wherein the content of the wood fibers which have been subjected to an acetylation treatment is 35-90% by weight of the total amount of both wood fibers which have been subjected to an acetylation treatment and wood fibers which have not been subjected to an acetylation treatment. US 582 does not disclose applying a heated solution of 140-210°C to the wood in an acetylating process. Instead, US 582 discloses a specific method for acetylation in the vapor phase, in which the reaction temperature is around 140-210°C and the reaction pressure is at atmospheric pressure. In contrast to the method used in US 582, the acetylation reaction claimed in the current application is performed in liquid phase. As discussed above, maintaining the entire working solution in liquid phase at a super hot temperature maximizes the loading of the acetic anhydride into the wood and simultaneously causes extremely rapid acetylation reaction in the wood, resulting in less steps in the process, significantly faster acetylation reaction time, and produces a better yield in acetylated final product. Therefore, as the acetylation reaction performed in vapor phase at 140-210°C in US 582 is sharply distinct from the acetylation reaction performed in liquid phase at 150-250°C in the current application, it would not have been obvious to one of ordinary skill in the art to apply a super hot working solution to the wood, while supplying sufficient pressure to maintain the working solution in liquid phase, during an acetylation reaction, as prescribed in claims 25-26 in the current application.

In view of the reasons proffered above, Applicant submits that EP 810, US 407, US 998, and US 582, either separately or combined, fail to disclose all of the claimed limitations of independent claims 1, 31, and 32 of the current application

CONCLUSION

In view of the foregoing amendments and remarks, Applicant believes that the claims are in condition for allowance. Reconsideration, re-examination, and allowance of all claims are respectfully requested. If the Examiner feels that a telephone interview may help further the examination of the present application, the Examiner is encouraged to call the undersigned attorney or his associates at the telephone number listed below.

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Respectfully submitted,

/Vic Lin/ May 28, 2010

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